SHORT COMMUNICATION

Genotype x Environment Interactions for Forage Productivity in Oats (*Avena sativa* L.)

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Stability parameters in 33 oat genotypes were studied to obtain information on the magnitude and nature of G x E interactions and stability for forage yield. These genotypes evaluated under three environments i.e. E_1 (2006-07), E_2 (2007-08) and E_3 (2008-09), depicted significant interaction with the environments for both green fodder and dry matter yields. OS 7, a high yielding genotype and responsive to favourable environment, was found to be the most unstable one for both the characters. The high yielding genotypes which were stable over environments and responsive to favourable conditions included JHO-851, OS-297 and OS 293. The genotypes OS 311, OS 315, JHO 2000-6 and JHO 2000-2 were high yielding, responsive to poor environment and least deviating from regression while UPO 271 was found to be high yielding, responsive to average environment and stable one.

Key Words: Forage productivity, Oats, *Avena sativa*, G x E interaction

Oats (*Avena sativa* L.) is an important cereal forage crop in the temperate, sub termperate and tropical climates of the world. It provides high tonnage of nutritious green fodder in a short period of 100-120 days. It is generally widely adapted in northern and north western regions of India where it is extensively grown in winter season under limited irrigation facilities. Genotype x Environment interactions constitutes a serious problem in recommending a variety for a specific region because crop outcome is a product of the genotype and the environment in which crop has been grown (Zaheri and Bahraminejad, 2012). Environment for commercial cultivation cannot be changed but genotype can be modified to suit the available soil and climate related environmental conditions. Ideal variety is always one, which possesses general adaptation with higher yield potential. A variety is considered to be more adaptive or stable if it has high mean but low degree of fluctuations in yielding ability when grow over diverse environments (Arshad *et al*., 2003). As such, screening of genotypes under varying environmental conditions is an essential part of the breeding programmes. Stability across many locations and years could increase both repeatability and heritability of important traits (Akcura, *et al*., 2005; and Wekai *et al*., 2010).

The present study was, therefore, aimed at investigating the stability parameters in 33 genotypes to obtain information on the magnitude and nature of G x E interactions and stability for forage yield in oats in order to identify high yielding and stable genotypes.

The field experimental was conducted at Regional Agricultural Research Station, Rajouri of Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu (J&K), during the *rabi* seasons of 2006-07, 2007-08 and 2008-09 under normal fertility conditions. Thirty three genotypes of forage oats, including two national checks (NC) *viz*. JHO 851 and Kent; and one zonal check (ZC) *viz.* Sabzar (Table 1) differing in forage productivity, comprised the experimental material for the present study. These genotypes were evaluated under three environments i.e. E_1 (2006-07), E_2 (2007-08) and E_3 (2008-09). Each of the environments was considered as an independent environment. The genotypes were sown in the first week of November each year i.e. November 7^{th}, 2006, November 5^{th}, 2007 and November 3^{nd}, 2008 for E_1, E_2 and E_3, respectively. Sowings were done in randomized complete-block design (RCBD) with three replicates in plots each having four rows of 4 m length with inter-row spacing of 30 cm. Each genotype was harvested in two

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cuts, first cut at 50 per cent blooming stage which falls at 90-95 days after sowing and second cut at 60-65 days after first cut. Recommended doses of N (80 Kg/ha) and P (40 Kg/ha) were applied. N was applied in two split doses (first dose of 40 Kg/ha at the time of seeding and the second dose of 40 Kg/ha N after first cut). One pre-sown irrigation and two irrigations during crop growth cycle (first at tillering stage and second after first cut) were ensured. Data on green fodder yield were obtained from each plot of size 4.80 m^2. One Kg green fodder sample of each genotype was oven dried and from this dry matter yield was calculated in Kg/plot. The analysis for green fodder and dry matter yield was done after converting the data into quintals/ha. The data were subjected to stability analysis using established model suggested by Eberhart and Russel (1966).

The joint regression analysis (Table 1) revealed that significant variability among environments varying from year to year as well as among genotypes for both the characters. Appraisal of data further revealed that genotypes interacted significantly with the environments for both green fodder and dry matter yields. Non-significant environment (linear) variance for green fodder yield suggested that variation among environments is not linear for this trait. However, this variation was found to be linear for dry matter yield, revealing thereby that the prediction of the trait across environments was possible (Muhammad, *et al*, 1993). However, variance due to G x E (linear) was highly significant implying thereby the differential yield performance of genotypes under different environments but with considerably varying reaction norms i.e. the linear sensitivity of different genotypes was variable. Therefore, prediction for most of the genotypes appears to be possible for green fodder and dry matter yield. Thus most of the variation was due to linear differences between linear slopes of regression for the characters studied. Such observations have been made earlier by Link *et al*., 1994, Malhotra *et al*., 1995; Hussain *et al*., 2002). Besides,

Table 1. Joint regression analysis of green and dry matter yield in oats

Source	d.f.	Mean Squares Green fodder yield	 Dry matter yield
Genotypes (G)	32	2478.37**++	110.46**++
Environ. (E)+(GXE)	66	2696.82**++	93.98**++
Environ. (Linear)	1	1.12	035.55**++
G X E (Linear)	32	4485.18**++	60.68**++
Pooled deviation	33	1044.33	37.13
Pooled error	192	827.99	31.89

** Against pooled error at 1% level
++ Against pooled deviation at 1% level

the non-significant pooled deviation for both the traits suggests that the performance of different genotypes did not fluctuate significantly from their respective linear path of response to environments.

Mean green fodder yield (q/ha), regression (b) and deviation from regression (Sd^2) for 33 genotypes in three environments are given in Table 2. The over all mean performance of 33 genotypes varied from 271.48 q/ha (UPO 265) to 382.32 q/ha (OS311) for green fodder yield and from 53.23 q/ha (JHO 99-1) to 73.67 q/ha (OS 7) for dry matter yield. Data in Table 2 further revealed that most of the genotypes out yielded the check (Kent). However, six genotypes out yielded the better check (JHO 851) both for green fodder and dry matter yield. Among these, OS 311, OS 7, OS 315, UPO 271 and JHO 2000-6 gave significantly higher green fodder and dry matter yields over both the checks. Genotypes JHO 851, OS 314, OS 297, OL 1193, OS 313, UPO 212, JHO 99-2, OS 7, Black Nip, OL 1235, UPO 265, HJ 8 and OS 293 had regression coefficient more than unity for both green fodder and dry matter. Therefore, these genotypes may be expected to perform well under good environmental conditions. Genotypes UPO 271, JH 8, JHO 99-5, JHO 2000-4 and HFO 114 possessed 'b' values close to unity and were thus average responsive to changes in environments and could perform well under average environmental conditions. Genotypes JHO 99-1, OS 295, OL 9, OS 6, Sabzar, Kent, and FG 22 had 'b' values less than unity and could be expected to give better yield under poor environments. Among the genotypes studied for comparative performance of green fodder and dry matter, OS 7 was high yielding, but the most unstable genotype for both the characters. Remaining all the genotypes were stable for both green fodder and dry matter yield, as they had non-significant values for deviation from regression. In the present study, the term stability as advocated by Jatasra and Paroda (1979) has been used. Observations with respect to identification of high yielding and stable strains of oats over environments have been made earlier (Gupta and Singh, 1997, Wani *et al*., 2002, Nehvi *et al*., 2007, Sun *et al*., 2009; Wekai *et al*., 2010).

Taking all the three parameters into consideration it could be noted that genotypes JHO 851, OS 297 and OS 293 were high yielding, responsive to favourable environments and stable ones. The genotypes OS 311, OS 315, JHO 2000-6 and JHO 2000-2 were high yielding, responsive to poor environment and stable over environments. Out of the high yielding genotypes, UPO 271 was found to

Table 2. Stability parameters for green and dry matter yield in oats

Genotype	Green Fodder Yield			Dry Matter Yield		
	Mean	b	S^-d^2	Mean	b	S^-d^2
JHO 99-1	287.46	-0.57	-285.77	53.23	-0.59	-16.62
UPO 271	366.96	1.05	-619.56	69.23	1.05	6.07
OS 295	350.39	0.34	3443.46**	60.48	0.37	91.55
JH 8	320.62	1.06	-151.43	58.29	0.99	-5.01
OS 315	373.88	0.78	778.32	71.92	0.82	-23.97
OL 9	322.98	-0.48	299.67*	56.69	-0.17	-3.62
JHO851(NC)	364.11	2.68**	-796.14	67.43	2.61	-31.86
OS 314	313.47	1.39	-818.59	59.14	1.37	-29.81
OS 297	379.69	1.38	940.81	64.35	1.25	-14.04
S 3021	326.15	0.82	0.86	62.72	0.80	-2.78
OL 1193	286.17	1.11	-810.42	55.81	1.17	-27.65
OS 296	334.16	0.98	1140.06	59.86	0.86	-30.42
OS 313	345.14	1.88	-678.31	63.24	1.80	-24.94
W 11	328.04	0.37	927.12	61.89	0.39	28.90
UPO212(NC)	341.02	1.23	411.55	66.87	1.29	10.95
JHO 99-2	333.24	2.02	-692.94	59.24	2.27	14.19
OS 7	373.81	2.91	5989.95**	73.67	2.88	242.79**
OS 303	340.40	0.10	-475.14	63.89	0.12	-13.40
OS 311	382.32	0.30	-352.19	67.71	0.66	-24.94
JHO 2000-2	355.00	0.92	-615.90	65.74	0.88	-21.84
OS 6	320.90	-0.17	132.84	57.32	-0.18	83.69
Sabzar (ZC)	315.46	-0.07	778.07	55.35	-0.10	16.94
Black nip	296.22	2.27	-746.82	54.20	2.03	-29.12
JHO 2000-6	367.35	0.90	743.99	72.04	0.95	24.97
OL 1235	332.40	1.58	152.11	57.31	1.45	-1.35
UPO 265	271.48	1.40	208.58	49.36	1.31	9.29
HJ 8	349.86	1.77	-699.08	68.74	1.83	-27.30
JHO 99-5	295.04	1.01	-620.09	56.74	1.00	-21.12
Kent (NC)	315.81	0.12	-434.03	57.42	0.12	-19.06
JHO 2000-4	298.50	1.00	-744.93	53.30	0.94	-26.00
HFO 114	330.06	1.05	1142.26	55.94	0.90	30.76
OS 293	351.57	1.70	83.88	60.61	1.55	-8.80
FG 22	331.16	0.09	-792.41	64.02	0.17	-30.31
Overall Mean	**333.36**			**61.32**		

* Significant at 5 per cent level
** Significant at 1 per cent level

be high yielding under average environment and stable one.

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